



STRUCTURAL CHANGES IN INDIVIDUAL RETINAL LAYERS IN DIABETIC MACULAR EDEMA: AN OBSERVATIONAL STUDY

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Abstract

Background: Diabetic macular edema (DME) is a major cause of visual impairment in patients with diabetic retinopathy. Optical coherence tomography (OCT) provides high-resolution cross-sectional imaging of the retina and allows quantitative assessment of individual retinal layers. Structural alterations in specific retinal layers may be associated with visual dysfunction and the severity of macular edema.

Aim: To study the structural changes in individual retinal layers in patients with diabetic macular edema using spectral-domain optical coherence tomography.

Materials and Methods: A hospital-based observational study was conducted among 40 patients with diabetic macular edema attending the Department of Ophthalmology. Patients underwent comprehensive ophthalmic examination including best-corrected visual acuity, slit-lamp examination, fundus examination and spectral-domain OCT of the macula. Central macular thickness and thickness/structural abnormalities of individual retinal layers were evaluated. OCT findings including intraretinal cystoid spaces, disorganization of retinal inner layers, disruption of the ellipsoid zone and external limiting membrane, and changes in the outer retinal layers were documented.

Results: Among the 40 patients studied, OCT demonstrated variable involvement of individual retinal layers. The most commonly observed structural abnormalities included increased central macular thickness, intraretinal cystoid spaces and alterations of the inner retinal layers. Disruption of the ellipsoid zone and other outer retinal structures was observed in patients with more pronounced macular involvement. Visual acuity showed a tendency to be poorer in patients with greater structural disruption.

Conclusion: Diabetic macular edema is associated with structural alterations involving multiple retinal layers. OCT provides useful quantitative and qualitative information regarding these changes and may help in assessing the severity and functional consequences of DME.

Keywords: Diabetic macular edema, optical coherence tomography, retinal layers, central macular thickness, ellipsoid zone, OCT.

Introduction

Diabetic retinopathy is one of the most important microvascular complications of diabetes mellitus and is a major cause of visual impairment. Diabetic macular edema occurs because of breakdown of the blood-retinal barrier, increased vascular permeability and accumulation of fluid within retinal tissue.

The macula consists of multiple anatomically and functionally distinct retinal layers. Diabetes-related edema can affect different retinal compartments, producing intraretinal cystoid spaces, thickening of individual layers and disruption of normal retinal architecture. Spectral-domain optical coherence tomography has become an important investigation in the diagnosis and monitoring of DME because it provides high-resolution cross-sectional images and permits evaluation of retinal thickness and individual retinal-layer integrity.

Structural abnormalities such as disorganization of the retinal inner layers, disruption of the ellipsoid zone and external limiting membrane, and changes in the outer retinal layers may have implications for visual function. Therefore, assessment of individual retinal layers may provide additional information beyond measurement of overall central macular thickness.

Aim

To study structural changes in individual retinal layers in patients with diabetic macular edema using spectral-domain optical coherence tomography.

Objectives

- To evaluate retinal structural changes in patients with DME using OCT.
- To measure central macular thickness.
- To assess individual retinal-layer involvement.
- To document intraretinal cystoid spaces and other OCT features of DME.
- To evaluate the relationship between retinal structural changes and visual acuity.

Materials and Methods

Study Design: Hospital-based observational study.

Study Population: 40 patients diagnosed with diabetic macular edema.

Study Setting: Department of Ophthalmology, Jayapriya Eye Hospital, Hubli.

Study Duration: October 2023 to December 2023.

Inclusion Criteria

- Patients diagnosed with diabetes mellitus.
- Patients with diabetic macular edema on clinical examination and OCT.
- Patients willing to participate in the study.
- Patients with adequate-quality OCT scans.

Exclusion Criteria

- Previous retinal surgery.
- Other causes of macular edema.

- Retinal vascular occlusive diseases.
- Age-related macular degeneration.
- Significant media opacity interfering with OCT imaging.
- Other retinal diseases that could independently affect retinal thickness.

Ophthalmic Evaluation

All patients underwent best-corrected visual acuity assessment, slit-lamp examination, intraocular pressure measurement, dilated fundus examination, fundus photography where indicated, and spectral-domain OCT of the macula.

OCT Assessment

The following structural parameters were evaluated: central macular thickness (measured in μm); inner retinal layer thickness/structural integrity; inner nuclear layer structural changes/cystic spaces; outer plexiform layer thickening/cystic changes; outer nuclear layer structural integrity; ellipsoid zone integrity; external limiting membrane integrity; intraretinal cystoid spaces; subretinal fluid; and disorganization of retinal layers.

Results

A total of 40 patients with diabetic macular edema were included. The largest age group was 50–59 years (35%), followed by 60–69 years (32.5%). Twenty-four patients (60%) were male and 16 (40%) were female.

Table 1. Age Distribution

Age group	Number	Percentage
40–49 years	8	20%
50–59 years	14	35%
Age group	Number	Percentage
60–69 years	13	32.5%
≥ 70 years	5	12.5%
Total	40	100%

Table 2. Sex Distribution

Sex	Number	Percentage
Male	24	60%
Female	16	40%
Total	40	100%

Table 3. OCT Structural Findings

OCT finding	Number	Percentage
Increased central macular thickness	40	100%
Intraretinal cystoid spaces	32	80%
Disorganization of retinal inner layers	18	45%
Ellipsoid-zone disruption	14	35%
External limiting membrane disruption	10	25%
Subretinal fluid	6	15%

Table 4. Visual Acuity According to Retinal Structural Changes

Structural finding	Number of patients	Mean BCVA (logMAR)
Predominantly inner retinal changes	18	0.42 ± 0.21
Inner + outer retinal changes	12	0.68 ± 0.29
Ellipsoid-zone disruption	14	0.74 ± 0.31
Severe multilayer disruption	8	0.91 ± 0.35

Discussion

The present study demonstrates that diabetic macular edema is associated with structural abnormalities involving multiple retinal layers. OCT allows visualization of these changes and provides information regarding both retinal thickness and retinal microstructural integrity.

Increased central macular thickness and intraretinal cystoid spaces were common findings. These features reflect accumulation of extracellular fluid associated with disruption of the blood-retinal barrier. Disorganization of the retinal inner layers may reflect structural damage associated with chronic DME and may be associated with reduced visual function.

The outer retinal structures are also important for visual function. Disruption of the ellipsoid zone and external limiting membrane was associated with poorer visual acuity in the present analysis. Central macular thickness alone may not adequately describe functional status because patients with similar

thickness measurements may have different visual acuities depending on the degree of inner and outer retinal damage.

These observations are consistent with published OCT studies in which DRIL, ellipsoid-zone disruption and external limiting membrane abnormalities have been associated with visual acuity in DME. Recent systematic reviews also support the clinical relevance of OCT biomarkers while emphasizing the need for standardized definitions and control of confounding factors.

Conclusion

Diabetic macular edema produces structural abnormalities involving multiple retinal layers. Spectral-domain OCT is a valuable non-invasive modality for identifying these changes. In this 40-patient study, increased central macular thickness and intraretinal cystoid spaces were common findings. Disorganization of the inner retinal layers and disruption of outer retinal structures, particularly the ellipsoid zone, were associated with poorer visual function. Assessment of individual retinal-layer integrity in addition to central macular thickness may therefore provide a more comprehensive evaluation of patients with diabetic macular edema.

Study setting: Department of Ophthalmology, Jayapriya Eye Hospital, Hubli

Study duration: October 2023 to December 2023

Study population: 40 patients

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